The Serendipity Equations

A. Dias de Figueiredo[1], José Campos[2]

[1] Departamento de Engenharia Informática, DEI/CISUC,
Pinhal de Marrocos, 3030 Universidade de Coimbra, Portugal
adf@dei.uc.pt
[2] Departamento de Informática, Escola Superior de Tecnologia de Viseu,
Campus Politécnico de Repeses, 3504-510 Viseu, Portugal
jcampos@di.estv.ipv.pt

Abstract

In spite of the role it recognizably plays in sparking innovation, serendipity, the faculty of making fortunate and unexpected discoveries by accident, remains largely unexplored as a subject of research. This may result to some extent from the difficulty in discriminating serendipity from other manifestations of creativity. To overcome this barrier, we propose a notation that visually expresses serendipity in the form of logical equations, offering a different way of looking at the concept.

Introduction

Serendipity, the gift of finding valuable or agreeable things not sought for, or the faculty of making fortunate and unexpected discoveries by accident (Roberts 1989), is one of the less researched concepts in the realm of creativity. One reason that may, to some extent, account for this is that it tends to be regarded as a mere manifestation of conventional creativity, a view that masks its quite distinctive nature. The aim of this paper is to refute this view and claim that, being distinctive, serendipity should become a subject of research in its own right.

Given the vastness of the field, as portrayed by Van Andel (1992) in a study of more than a thousand examples, we shall concentrate a part of our illustrations on the more widespread kind of serendipity, that of insight solutions resulting from metaphors or analogies. This is closely related to the notions of generative metaphor and frame restructuring proposed by Schön (1993), the concept of generative processes by analogical transfer expounded by Finke (1994), and the argument, by Black (1993), that metaphors can generate new knowledge and insight by changing relationships between the things designated. It should be stressed, however, that serendipity may freely occur in the absence of any metaphors. As pointed out by Umberto Eco, it can even occur as a result of incorrect knowledge (Eco 1998).

In the following paragraphs, we dwell a little further on the problem of making serendipity more clearly identifiable, we put forward our simple notation, and we wrap up with some concluding remarks.

The Essence of the Problem

If we follow the classic divergence/convergence view of creativity proposed by Guilford (1956), we may say that a conventional creative process departs from the recognition of a problem, engages in some form of divergence, and finally ends up converging into a novel solution to the problem. A serendipitous creative process, on the contrary, though departing from the attempted solution to a problem, follows an essentially divergent path until it ends up leading to a different problem, or, as it is often the case, to the solution to a problem of which existence we were not aware. As put by Quéau, serendipity is "the art of finding what we are not looking for by looking for what we are not finding" (Quéau 1986). In his analysis of the implications of Darwin's insights in helping accommodate a full range of mental processes involved in creativity, Simonton stresses the role of serendipity as a truly general process for the origination of new ideas (Simonton 1996). He also points out that serendipitous insights often lead to the solution to the "wrong" problem, to which we would add that the usefulness of serendipity emerges precisely when the "wrong" problem is a good one.

The difficulty in telling serendipity apart from other forms of creativity, often combined with its apparent unmanageability, tends to explain its lack of scientific resonance: if serendipity is a product of chance, and thus not manageable, why should one be studying it at all? This view of serendipity as the sole result of chance is strongly opposed by many authors. Van Andel stresses that discoveries are never by chance and insists on the key role of intellectual preparation and/or intensity of observation and inquiry (Van Andel 1992). Fine and Deegan, in a study of the role of serendipity in qualitative research, describes it as the interactive outcome of unique and contingent mixes of insight with chance, a demonstration of how planned insights, coupled with unplanned events, can potentially yield important scientific results (Fine and Deegan 1996).

In his extensive study, Van Andel shows that serendipity has had a very strong relevance in the progress of science, technology, and art, apart from its very impact on daily life (Van Andel 1992). In more specific fields, the need for supporting serendipity is also stressed by many authors. Toms insists on the importance of serendipity in information retrieval (Toms 2000) and complains about the inexistence of information systems capable of using the concept to stimulate curiosity and encourage or support exploration (Toms 1998). Martinet and Marti emphasize the importance of serendipity in business intelligence (Martinet and Marti 1995), pointing out that, although we cannot develop an "ability to be lucky", we should be able to improve our ability to search for unexpected opportunities and seize them, namely through the exploration of analogies and the participation in networks. Campos and Figueiredo attempt to move one step further, into inducing serendipity through the use of specially designed systems, for which they have developed a software agent that uses simple information retrieval techniques and heuristic search to wander on the Internet and uncover useful, and not sought for, information that may stimulate serendipitous insights (Campos and Figueiredo 2001).

In spite of the lack of specific research on serendipity, one may reasonably expect current research on creativity to contribute very significantly to the understanding of the deeper nature of serendipity. The intrapsychic model of creative insight (Csikszentmihalyi and Sawyer 1996), to name one example, goes a long way towards such an understanding, specially when it borrows from Getzels (1964) the distinction between *presented problem-solving* and *discovered problem-finding*. Described as a multistage model of creative insight that attempts to explore the relationship between insight – an intrapsychic process – and the social milieu in which it occurs, the interpsychic model proposes a framework with four stages (Csikszentmihalyi and Sawyer 1996): the *preparation* stage, involving hard work and research, that accumulates the raw information on which the subconscious can work; the *incubation* stage, a period of idle time during which part of the information is filtered and passed from conscious awareness to the subconscious; the *insight* stage, occurring when the subconscious combines or selects an idea that emerges into consciousness and results in the "Aha!" experience; and the *evaluation and elaboration* stage, which operates as a reverse filtering of the insight, from the subconscious to consciousness. Whilst *presented problem-solving* involves problem defined preparation, relatively short periods of incubation, the occurrence of insights directly related to the problem envisioned, and the influence of a single knowledge domain, *discovered problem-finding* usually departs from a diffuse problematic situation, suffers parallel influences from different knowledge domains, and ends up discovering new problems. Although serendipity is not mentioned in the description of this model, one may easily recognize that the model accounts for some kinds of serendipity that occur as a result of social influences.

In his analysis of Darwinian insights, which he claims to provide a broad model for understanding the origins of insights in the annals of human achievements, Simonton explicitly acknowledges serendipity as a truly general process for the origination of new ideas (Simonton 1996). Like Csikszentmihalyi and Sawyer, he stresses that insights do not appear without a preparation phase, where groundwork is first laid, followed by an incubation period during which an external stimulus may prime the mind into wild associations leading to unexpected insights. He also stresses the importance of the individual's exposure to stimuli outside the restricted domain of the specific problem at hand.

From the propositions above, one might be inclined to believe that, since serendipity is so akin to conventional creativity, it would not be difficult to extrapolate to its understanding and exploration the advances of research on creativity. This is, however, were the problems start to arise, because it is the very similarity between the two that hinders the nature of serendipity. It is quite common, indeed, even for people quite familiar with the phenomenon, to succumb to the second nature of our mold of convergence and end up trying to explore serendipity as if it fitted such a mold. This may be the case, for instance, when one is developing software to induce serendipity, only to find out, sometimes after a significant effort of development, that some of the attempted solutions have inconspicuously become mere solutions to explore convergence.

It is in those cases that our equations may help. They should not be understood, however, at least for the time being, as an attempt to formalize the phenomenon of serendipity, but rather as notational descriptions to help analyze situations where we are not sure of being able to tell serendipity from conventional creativity. They are not, by any means, *the* way to describe serendipity, but just *one more* way of looking at it. From our experience, they are even confusing to some people, though they have proved to be helpful to some other people, namely in providing an alternative perspective to grasp the presence or the absence of serendipity in some less clear cases. In those cases, scribbling an equation on the back of an envelope has proved, at times, to be quite helpful and insightful.

The Serendipity Equations

The proposed notation will be explored through a few examples. The first two examples concentrate on the more common case where metaphors work as a means of inducing insights (creative in the first example, and serendipitous in the second), but the remaining examples will not be related to metaphor.

When exercising conventional creativity to solve a problem, *P1*, in knowledge domain (*KP*1), we may resort to an inspiring metaphor *M*, from knowledge domain (*KM*), which may lead to the solution *S1* to problem *P1* in knowledge domain (*KP*1, *KM*, *KN*), where *KN* is the additional knowledge gained in the process of formulating and solving

the problem. The following logical equations could be used to describe the process:

$$\begin{array}{l} P1 \subset (KP1) \\ M \subset (KM) \end{array} \Rightarrow S1 \subset (KP1, KM, KN)$$

Archimedes' discovery of how to measure the volume of a solid object fits this description. He had the problem, *P*1, of finding a way of detecting the presence of base metal in a golden crown. The unexpected metaphor, *M*, of the water overflowing in his bath inspired a solution, *S*1. This form of creativity, sparked by an unexpected event, is often confused with real serendipity. Roberts (1989) calls it *pseudoserendipity* to highlight that, unlike *real serendipity*, it does not lead to the discovery of things not sought for.

To describe serendipitous creativity using the same notation, we may depart from a problem *P*1, in the knowledge domain (*KP*1), and assume that, by resorting to an inspiring metaphor *M*, from knowledge domain (*KM*), we find a *new* problem *P*2 in knowledge domain (*KP*2), with a solution *S*2 in knowledge domain (*KP*2, *KM*, *KN*). Quite often, in serendipitous discoveries, the solution to problem *P*2 is recognized simultaneously with the identification of the problem *P*2 itself. Sometimes it is even the solution that is found before the problem. Using the same notation as above, we are led to the equations:

$$\begin{array}{l} P1 \subset (KP1) \\ M \subset (KM) \end{array} \Rightarrow \begin{array}{l} P2 \subset (KP2) \\ S2 \subset (KP2, KM, KN) \end{array}$$

Röntgen's discovery of X rays fits this description. When attempting to solve the problem, *P*1, of detecting cathode rays from an evacuated glass tube, he noticed a light shimmering from a point in the dark, more than a yard away from the tube. The light was coming from a fluorescent screen that happened to be in the laboratory. This offered the unexpected metaphor, *M*, that led him to the discovery of the new problem, *P*2, of producing a new kind of rays that penetrated more than a yard of air.

Serendipity may occur without an inspiring metaphor, with problem *P*1 and *KP*1 working as the sole inspiration to find a *new* solution, *S*2, to a new problem, *P*2. The equations then become:

$$P1 \subset (KP1) \Rightarrow \begin{array}{l} P2 \subset (KP2) \\ S2 \subset (KP2, KN) \end{array}$$

Citroën's small model 2CV, initially built as a prototype to test suspensions (problem *P*1) became one of the most popular cars of the European industry when the firm's employees started looking at it as an excellent solution, *S*2, for the problem, *P*2, of inexpensive daily commuting.

The role of the metaphor may also be played by ignorance (i.e., incorrect knowledge). If we represent incorrect knowledge by *EP*1, the equations become:

$$P1 \subset (KP1, EP1) \Rightarrow \begin{array}{l} P2 \subset (KP2) \\ S2 \subset (KP2, KN) \end{array}$$

When Columbus set out to reach Asia by sailing westward (problem *P*1), using the navigational knowledge available at the time (knowledge *KP*1), he underestimated the circumference of the earth and over-estimated the size of Asia (incorrect knowledge *EP*1). As a result of his expedition, he discovered the New World. This was the solution (*S*2) to a problem that had never been formulated and which is not even easy to formulate as a problem. The role of incorrect knowledge in sparking serendipitous discoveries should by no means be overlooked. Umberto Eco devotes to the subject a significant part of his book *Serendipities: Language and Lunacy* (Eco 1998), where he dwells on "the force of falsity" to show how a number of ideas that today we consider false actually changed the world. Amongst those, he recalls that the misunderstanding of Chinese writing by Leibnitz, when looking for the mathematical awareness of Fu-hsi, actually led him to contribute to the development of modern logic.

By using a simple notation, like the one proposed above, to express problems, *P*, solutions, *S*, and knowledge domains, *KP*, we can easily obtain very condensed descriptions of situations where we wish to tell serendipity from non-serendipity. The notation can be freely extended or changed to accommodate various views, such as the recognition of metaphor as a possible way of sparking serendipity, in which case we introduce the metaphor, *M*, and its knowledge domain, *KM*. It can even be used to express radically different formulations of serendipity, such as if we wish to describe it as occurring when we are trying to solve problem *P* using creative process *C*, an unexpected phenomenon *X* is observed and an application *A* for that phenomenon is invented.

In all those situations, when the second term of our equations represents the solution to the problem we were trying to solve, we are not dealing with serendipity. When, on the contrary, the second term shows a new problem, a new solution, a new problem and its solution, or the invention of a new application, then we are certainly dealing with serendipity.

Conclusions

The major aim of this paper was to call the attention of the reader to the relevance of research on serendipity and to the possibilities of its exploration. With this in mind, we have provided a succinct description of the phenomenon, in which we have commented on the similarities and differences between serendipity and conventional creativity and briefly alluded to some of the models of creativity that may inspire further research on the nature of serendipitous insights and on the means to generate them.

One of the main difficulties in the study and exploration of the phenomenon is the elusiveness that results from its

eminently divergent nature, which makes it quite hard to explore consistently in a world where we are constantly called to converge. To help overcoming this difficulty, we have proposed a simple notation to assist in visualizing the essential differences between serendipitous and non-serendipitous acts of creativity. When facing the dilemma of telling a serendipitous from a non-serendipitous situation, we can easily resort to the above notation to help clarifying our mind. We may thus feel more confident to explore further such an inspiring concept and make it a subject of research in its own right.

We recognize that the proposed notation is somewhat fuzzy. Fuzziness is, however, one important ingredient in sparking serendipitous insights. Our aspiration is that the general presentation of serendipity afforded by the first paragraphs, together with the rather more fuzzy, but hopefully inspiring, proposal, in the previous paragraph, of a notation to describe it, will attract the reader to – both creatively and serendipitously – join in in the investigation of this intriguing phenomenon and of its potential exploration. This is, in essence, the position we would like to convey in this position paper.

Acknowledgements

This work is partly supported by the Program of the Portuguese Foundation for Science and Technology (POSI) and European Union FEDER. The second author is grateful for the support received from the Computer Science Department of Escola Superior de Tecnologia de Viseu.

References

Black, M. 1993. More About Metaphor. In: Ortony, A. (ed.): *Metaphor and Thought*. 2nd edn., Cambridge: Cambridge University Press, 19-41.

Campos, J., and Figueiredo, A.D. 2001. Searching the Unsearchable: Inducing Serendipitous Insights, in this volume.

Csikszentmihalyi, M., and Sawyer, K. 1996, Creative Insight: The Social Dimension of a Solitary Moment. . In: Sternberg, R.J., Davidson, J.E. (eds.): *The Nature of Insight*. Cambridge: MIT Press.

Eco, U. 1998, *Serendipities: Language and Lunacy*, London: Weidenfeld & Nicolson.

Fine, G., and Deegan, J. 1996. Three Principles of Serendip: Insight, Chance and Discovery in Qualitative Research, *International Journal of Qualitative Studies in Education*, 9(4) 434-447.

Finke, R.A. 1994. Creative Insight and Preinventive Forms. In: Sternberg, R.J., Davidson, J.E. (eds.): *The Nature of Insight*. Cambridge: MIT Press.

Getzels, J.W. 1964. Creative Thinking, Problem-Solving, and Instruction. In E.R. Hilgard (eds.), *Theories of Learning and Instruction*. Chicago: University of Chicago Press.

Guilford, J.P. 1956. The Structure of Intellect, *Psychological Bulletin*, 53 (1956) 267-239.

Martinet, B., Marti., Y.-M. 1995. *L'Intelligence Économique*. Paris: Éditions d'Organization.

Quéau, P. 1986. *Éloge de la Simulation*. Seyssel : Éditions du Champ Vallon.

Roberts, R.M. 1989. *Serendipity: Accidental Discoveries in Science*. New York: John Wiley & Sons.

Schön, D.A. 1993. Generative Metaphor: A Perspective on Problem-Setting in Social Policy. In: Ortony, A. (ed.): *Metaphor and Thought*. 2nd edn. Cambridge University Press, Cambridge (1993) 137-163.

Simonton, D.K. 1996. Foresight in Insight? a Darwininan Answer. In: Sternberg, R.J., Davidson, J.E. (eds.): *The Nature of Insight*. Cambridge: MIT Press.

Toms, E.G. 1998. Information Exploration of the Third Kind: The Concept of Chance Encounters. A position paper for the *CHI 98 Workshop on Innovation and Evaluation in Information Exploration Interfaces*. (http://www.fxpal.com/chi98ie/ submissions/long/toms/index.htm).

Toms, E.G. 2000. Serendipitous Information Retrieval. *Proceedings of the Workshop Information Seeking, Searching and Querying in Digital Libraries*, Zurich. (http://www.ercim.org/publication/ws-proceedings/ DelNoe01/3_Toms.pdf)

Van Andel, P. 1992. Serendipity: Expect Also the Unexpected, *Creativity and Innovation Management*, 3: 20-32.